REMARKS

Claims 1-32 are pending. By this amendment the specification and claims 4, 12, 14 and 19 are amended, and new claims 26-32 are added. Reconsideration in view of the amendments and the following remarks is respectfully requested.

In paragraph 1 of the Office Action, the Examiner indicates that the July 28, 1999 IDS does not comply with the provisions of 37 C.F.R. However, the three Japanese language references identified and the Office Action correspond to U.S. Application serial numbers 08/463,550, 08/885,192 and 08/965,030, respectively. Accordingly, Applicants have complied with the English language requirement regarding the Japanese language references. Moreover, the Examiner has already initialed an Information Disclosure Statement acknowledging consideration of the U.S. applications.

Claims 4 and 12 were rejected under 35 U.S.C. § 112, second paragraph. By this Amendment, claims 4 and 12 have been amended to obviate the Examiner's comments. Withdrawal of the rejection is respectfully requested.

Claims 5, 6 and 10 were rejected under 35 U.S.C. 102(b) over Ruggierio et al. (US 4,878,770). This rejection is respectfully traversed.

Claim 5 defines a method of etching a metallic film on a thin film resistor, by dry-etching a first part of the metallic film and by wet-etching a second part of the metallic film to expose the thin film resistor. Thus, the metallic film is etched to expose the thin film resistor at two steps of dry-etching and wet-etching.

Ruggierio neither teaches nor suggests that the metallic film (i.e., TiW barrier layer 24) is etched to expose the thin film resistor 22 at two steps of dry-etching and wet-etching.

Ruggierio teaches on col. 3, lines 61-68 that wet etching is performed to remove aluminum, and then another wet etching is performed to remove the barrier layer 24. In this case, both etchings are wet. In <u>another</u> embodiment, Ruggierio further teaches on col. 4, lines

39-43 that all three layers 22, 24, 28 are removed by dry etching <u>simultaneously</u>. Thus, Ruggierio fails to teach not only that the barrier layer 24 is removed at the two steps of dry-etching and wet-etching, but also that the metallic layers on the thin film resistor 22 are removed at the two steps of dry-etching and wet-etching.

Therefore, claim 5 and its dependent claims (6, 10 and 26-27) are patentable over Ruggierio. Newly added claim 28 is also patentable at least because it defines that the metallic single film is etched at two steps of dry-etching and wet-etching.

Withdrawal of the rejection is respectfully requested.

Claims 7-9 and 11-18 were rejected under 35 U.S.C. 103(a) over Ruggierio. Claims 7-9 and 11 depend from allowable independent claim 5, which is addressed above. The rejection of claims 12-18 is respectfully traversed.

Claim 12 defines that the conductive film on the metallic film has a thickness equal to or less than 300 nm, and the conductive film is patterned so that a ratio of an upper surface area of the conductive film (i.e. the metallic film) relative to an upper surface area of the thin film resistor is equal to or more than 0.02.

The Examiner correctly recognizes that Ruggierio fails to specify the thickness and the ratio defined in claim 12 (and numerical values defined in claims 7, 8, 11, and 13). However, the Examiner asserted that it would have been obvious to modify Ruggierio by employing a variety of processing variables such as the thickness and area of the metallic layer, and rejected these claims. Applicants respectfully disagree with this Examiner's assertion.

The specific ranges of the thickness and the ratio defined in claim 12 were found out by the inventors to suppress the under-cut of the metallic film and the overhanging of the conductive film caused by etching. More specifically, the inventors considered ionization tendencies of the thin film resistor, the metallic film, and the conductive film and found out

the above specific values to solve the problems, as explained in the specification, from page 17, line 10 to page 20, line 22. Ruggierio neither teaches nor suggests the above problems to be solved by the invention. The specific values defined in the present invention could not be found out simply by conducting routine experimentation for the purpose of obtaining the best etched product in Ruggierio.

Therefore, claims 7, 8, 9 and 11-18 are patentable over Ruggierio. Withdrawal of the rejection is respectfully requested.

Claim 19 was rejected under 35 U.S.C. 102(b) over Nagahata. Further, claims 20 and 21, depending on claim 19, are rejected under 35 U.S.C. 103(a) over Nagahata in view of Iida. These rejections are respectfully traversed.

Claim 19 defines that, after forming a conductive layer on a metallic film through an oxide layer and patterning the conductive layer, the oxide layer and the metallic film is wet-etched. The conductive film is made of a material different from that of the metallic film. As defined in claim 30, the wet-etching is performed in a state where both the metallic film and the conductive film contact an etching solution.

In the wet-etching defined in claim 19, the surface oxide layer can prevent the conductive film from being etched undesirably (for example, tapered) due to a cell reaction (battery effect) that occurs between the conductive film and the metallic film. More specifically, as described in the specification, from page 29, line 18 to page 30, line 5, the surface oxide layer disturbs a flow of electrons between the metallic film and the conductive film, thereby reducing a potential difference between the metallic film and the conductive film that causes the cell reaction.

Nagahata teaches a stepped structure composed of first and second lead conductive layers 5 and 6, and an oxide film 7 that lies between the layers 5 and 6. However, in Nagahata, the first and second lead conductive layers 5 and 6 shown in FIGS. 1 and 4 are

made of the same material (Al), and, because of this, the oxide film 7 is disposed between the first and second conductive layers 5 and 6 to work as an etching stopper when the overlying second conductive layer 6 is etched.

Nagahata does not teach an oxide film disposed between conductive layers made of different materials from each other. Further, Nagahata does not explicitly teach that the overlying conductive layer 6 is wet-etched. This means that Nagahata fails to teach that both the first and second lead conductive layers 5 and 6 contact an etching solution during the wet-etching as defined in claim 30. The Examiner correctly recognizes this point. Thus, Nagahata neither teaches nor suggests not only the method as defined in claims 19 and 30 but also preventing a cell reaction between the first and second lead conductive layers 5 and 6.

On the other hand, Iida teaches a laminating structure of a CrSi thin film resistor 24, a TiW film 25, and an aluminum wiring layer 27. However, in Iida's structure, any oxide layer does not lie between the TiW film 25 and the aluminum wiring layer 27. Iida is silent about how to remove the TiW film 25. Iida is also silent about the above problem (concerning the cell reaction) solved by the present invention as defined in claim 19.

In addition, even if the oxide film 7 of Nagahata was applied to the laminating structure of Iida, it would be obvious to one ordinary skilled in the art that the oxide film 7 be disposed not between the TiW film 25 and the aluminum wiring layer 27 but in the aluminum wiring layer 27 (i.e., between first and second layers constituting the aluminum wiring layer 27). This is because the oxide film 7 of Nagahata is disposed between the first and second lead conductive layers 5 and 6 made of the same material to serve as an etching stopper and to form the stepped structure that makes the heating portion 4 (corresponding to the metallic film) contact a printed paper securely.

Incidentally, although FIG. 3 of Nagahata shows first and second lead conductive layers 5 and 6 made of the different materials from each other, any oxide film is not disposed

between the first and second lead conductive layers 5 and 6 in this structure that does not require an etching stopper between the layers 5 and 6.

In view of all the above, claims 9-21, and newly added claims 29-32, are patentable over Nagahata alone, or in combination with Iida.

Further, independent claim 31 defines that the metallic elm is wet-etched, in a state where both the metallic film and the conductive film, having ionization tendencies different from each other, contact an etching solution.

Withdrawal of the rejection is respectfully requested.

Claims 22-25 are also rejected under 35 U.S.C. 103(a) over Nagahata in view of Iida.

Claim 22 defines that, in a step of wet-processing first and second metallic films made of different materials from each other, an insulation film is disposed at least one of an interface between the first and second metallic films and a specific surface of the second metallic film contacting a solution. Accordingly, the insulation film can prevent a cell reaction from occurring between the first and second metallic films during the wet-processing, thereby preventing corrosion of base metal in the first and second metallic films.

Therefore, because of the same reasons as described above, claims 22-25 are also patentable over Nagahata in view of Iida.

Applicants appreciate the indication that claims 1-3 are allowed. However, in view of the above amendments and remarks, Applicants respectfully submit that all the claims define patentable subject matter and that the entire application is in condition for allowance.

Should the Examiner believe that anything further is desired to place the application in better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number listed below.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached Appendix is captioned **<u>"Version with markings to show changes made"</u>**.

Respectfully submitted,

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APPENDIX

VERSIONS WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

The specification is changed to read as follows:

Page 4:

According to a third aspect of the present invention, a conductive film is formed on a metallic film to have a thickness equal to or less than 300 nm, and the conductive film is patterned to have an upper surface area, a ratio of which relative to an upper surface area of a thin film resistor is equal to or more than 0.02. Then, the metallic film is etched through an opening of the conductive film. Accordingly, a variation in an etching amount produced due to a battery effect <u>(cell reaction)</u> between the conductive film and the metallic film is decreased to prevent over-hanging of the conductive film and under-cut of the metallic film.

IN THE CLAIMS:

4. (Amended) The method of claim 1, wherein the step of forming the mask includes steps of:

forming a photo-resist on the conductive film and in the first opening to serve as the mask; and

removing a part of the photo-resist [filling the first opening] to form the second opening.

12. (Amended) A method of etching a metallic film, comprising the steps of:

forming a metallic film on a thin film resistor;

forming a conductive film on the metallic film to have an opening exposing the metallic film therefrom and a thickness equal to or less than 300 nm;

patterning the conductive film so that [the conductive film has an upper surface area,] a ratio of [which] <u>an upper surface area of the conductive film</u> relative to an upper surface area of the thin film resistor is equal to or more than 0.02; and

etching the metallic film through opening of the conductive film.

14. The method of claim [15] <u>12</u>, wherein:

the step of patterning the conductive film includes a step of disposing a resist having a specific shape on the conductive film, and a step of etching the conductive film through the resist; and

the metallic film is etched through the conductive film holding the resist thereon.

19. A method of etching a metallic film, comprising the steps of:

forming a thin film resistor on a semiconductor substrate through an insulation layer interposed therebetween;

forming a metallic film on the thin film resistor;

oxidizing a surface portion of the metallic film to form a surface oxide layer on the metallic film;

forming a conductive film on the surface oxide layer;

patterning the conductive film to form an opening in the conductive film, the opening exposing the surface oxide layer therefrom; and

wet-etching the surface oxide layer and the metallic film,

<u>wherein the conductive film is made of a metallic material different from that of the metallic film</u>.